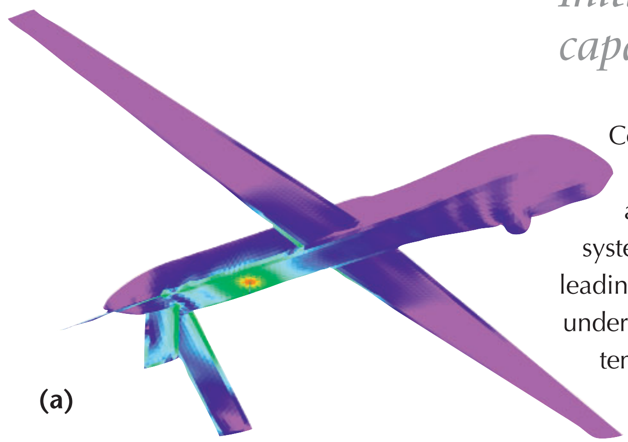
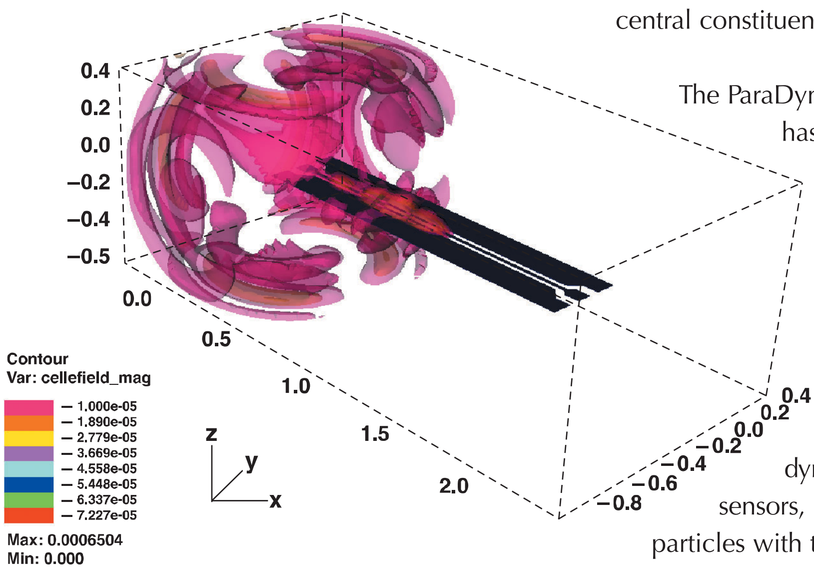
Computer simulation capabilities have become crucial to national security and infrastructure research

Initially only an adjunct to physical tests, [computational engineering] capabilities are now central constituents of our work.



(a)

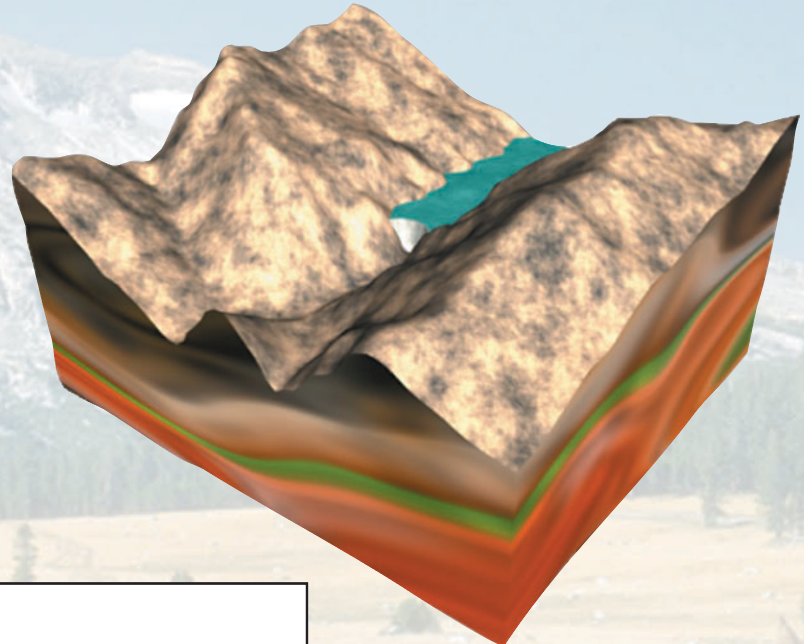


(b)

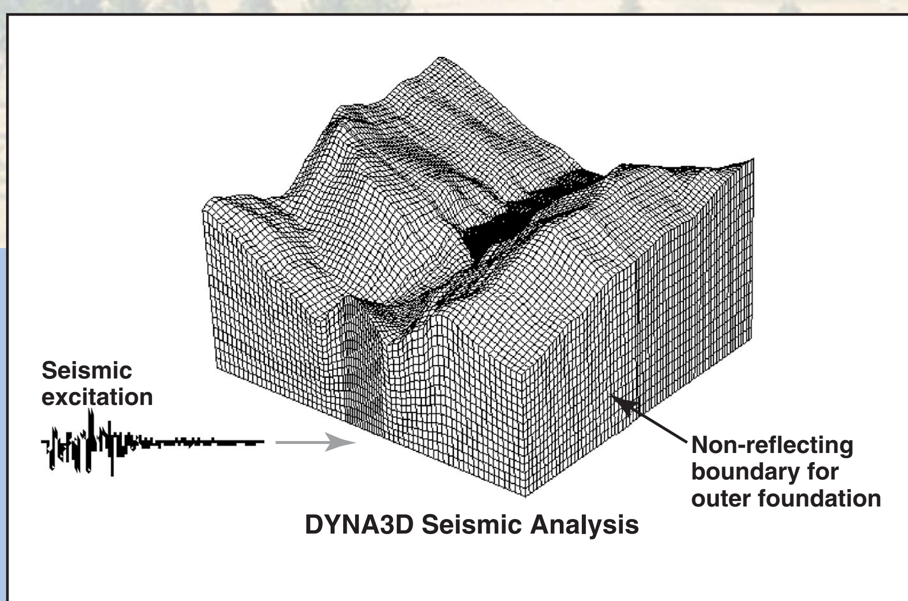
Computational engineering, which is the creation and use of numerical models to help understand and characterize the behavior of a component or system, is used extensively to both create futuristic leading-edge technology as well as develop greater understanding of existing engineered and natural systems. The national security mission of the Laboratory has motivated and supported much of Engineering's investment in simulation tools, and that trend has continued over the last two years. Initially only an adjunct to physical tests, these capabilities are now central constituents of our work.

The ParaDyn code for nonlinear structural dynamics has been widely used within ongoing nuclear weapon life extension projects both here and at Los Alamos National Laboratory. We have used and supported Defense and Nuclear Technologies' ALE3D hydrodynamics code for engineering studies such as interceptor impact lethality for the Missile Defense Agency. The flow dynamics within chemical and biological sensors, including the interactions of entrained particles with the channel walls and other features, are being modeled using an innovative lattice Boltzmann code to improve sensor sensitivity and efficiency. The communications links between Department of Defense (DOD) assets during critical operations are being addressed by an effort to predict the electronic battlefield environment. Also, the design of the next generation of Department of Defense mixed-signal systems (or systems-on-a-chip) is being addressed by applying an in-house developed code to high-frequency chip designs, thus integrating electromagnetic simulations with circuit models.

In addition to national security applications, we are also using state-of-the-art, sophisticated modeling capabilities to examine aspects of the nation's constructed infrastructure. We are currently simulating the Morrow Point Dam in Colorado in a study sponsored by the U.S. Bureau of Reclamation. To better characterize the seismic performance of this segmented concrete arch dam, not only are the dam and reservoir being modeled, but also the surrounding topography. The model is first gravity-loaded to establish the hydrostatic load response of the dam. Then the excitation of a representative seismic event is applied at the base of the model, and the resulting wave propagation and response of the dam and reservoir are computed. This model captures the effects of potential wave diffraction or focusing due to the topography. Also, the loading on the dam is more realistic as its periphery is not



uniformly excited. These efforts at increased fidelity have attracted the attention of academic researchers pursuing similar work.



DYNA3D Seismic Analysis

Left page, inset (a): *LLNL's EIGER code suite is used to predict the installed systems performance of key DOD assets. Here, the induced surface current on an unmanned air vehicle is shown. The radiation performance of this system can then be determined and optimized.*

Left page, inset (b): *The EMSolve tools are being applied to the challenging problem of mixed-signal systems design. The field distribution around a high-frequency transmission line is shown in this figure. From this analysis, coupling to other components and circuits can be determined.*

Right page: *An advanced finite element model of the Morrow Point Dam represents the dam, reservoir, and local topography in order to capture their interactions during an earthquake.*